(12) UK Patent Application (19) GB (11) 2 149 887 A

(43) Application published 19 Jun 1985

(21) Application No 8429008

(22) Date of filing 16 Nov 1984

(30) Priority data
(31) 3341641 (32) 17 Nov 1983 (33) DE

(71) Applicant
Mannesmann Rexroth GmbH (FR Germany),
Jahnstrasse, 8770 Lohr/Main, Federal Republic of Germany

(72) Inventors
Josef Distler
Gunter Fertig

(74) Agent and/or Address for Service
A R Davies & Co,
27 Imperial Square, Cheltenham GL50 1RQ

(51) INT CL[4]
F16K 11/07 F16H 39/44

(52) Domestic classification
F2V A6
F2W 026 028 194 206 208 224 298 312 C4
U1S 1762 1868 2013 F2V F2W

(56) Documents cited
GB 1503842 GB 1000500 GB 0907085

(58) Field of search
F2V
F2S
F2W

(54) A switching valve with brake pistons

(57) A valve with a control piston 11 for controlling the flow of pressure medium to a traction motor 40 is provided with brake pistons 15, 16 which are effective in both directions of travel and are controlled by the pump supply pressure. The control is so arranged that when the pump supply pressure rises fluid passes into a control chamber 55 through slots 57, 56 so that the appropriate brake piston 15, 16 is gradually opened against spring 18, in order to convey away to the reservoir T the pressure medium flowing back from the traction motor, while if the pressure drops off fluid leaves chamber 55 *via* non-return valve 60 and channel 58 so that the brake piston is quickly closed and thereby the flowback to the reservoir is throttled by an edge 52 of the piston. By this means a vehicle travelling downhill or a descending load may be effectively braked.

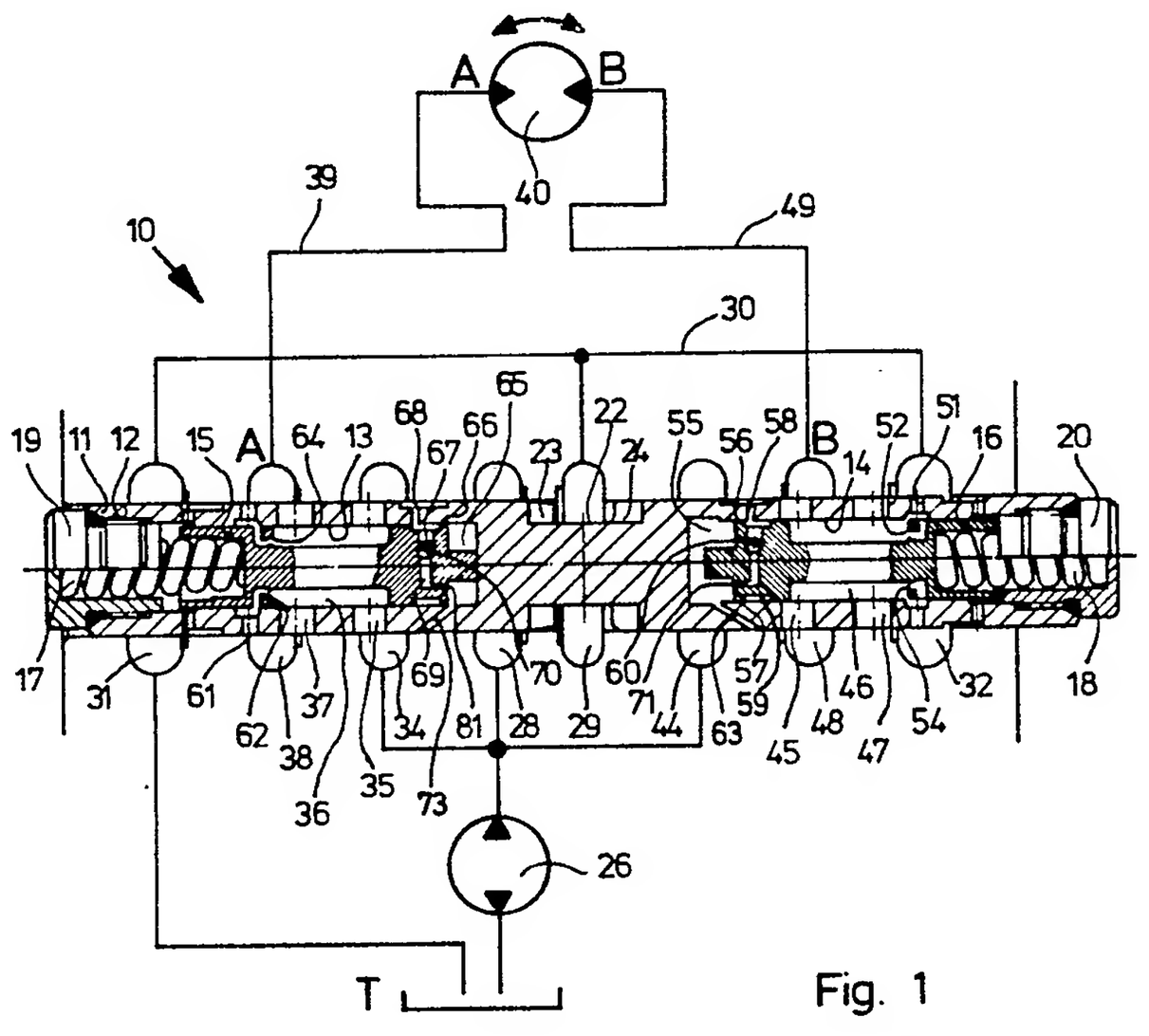

Fig. 1

The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

GB 2 149 887 A

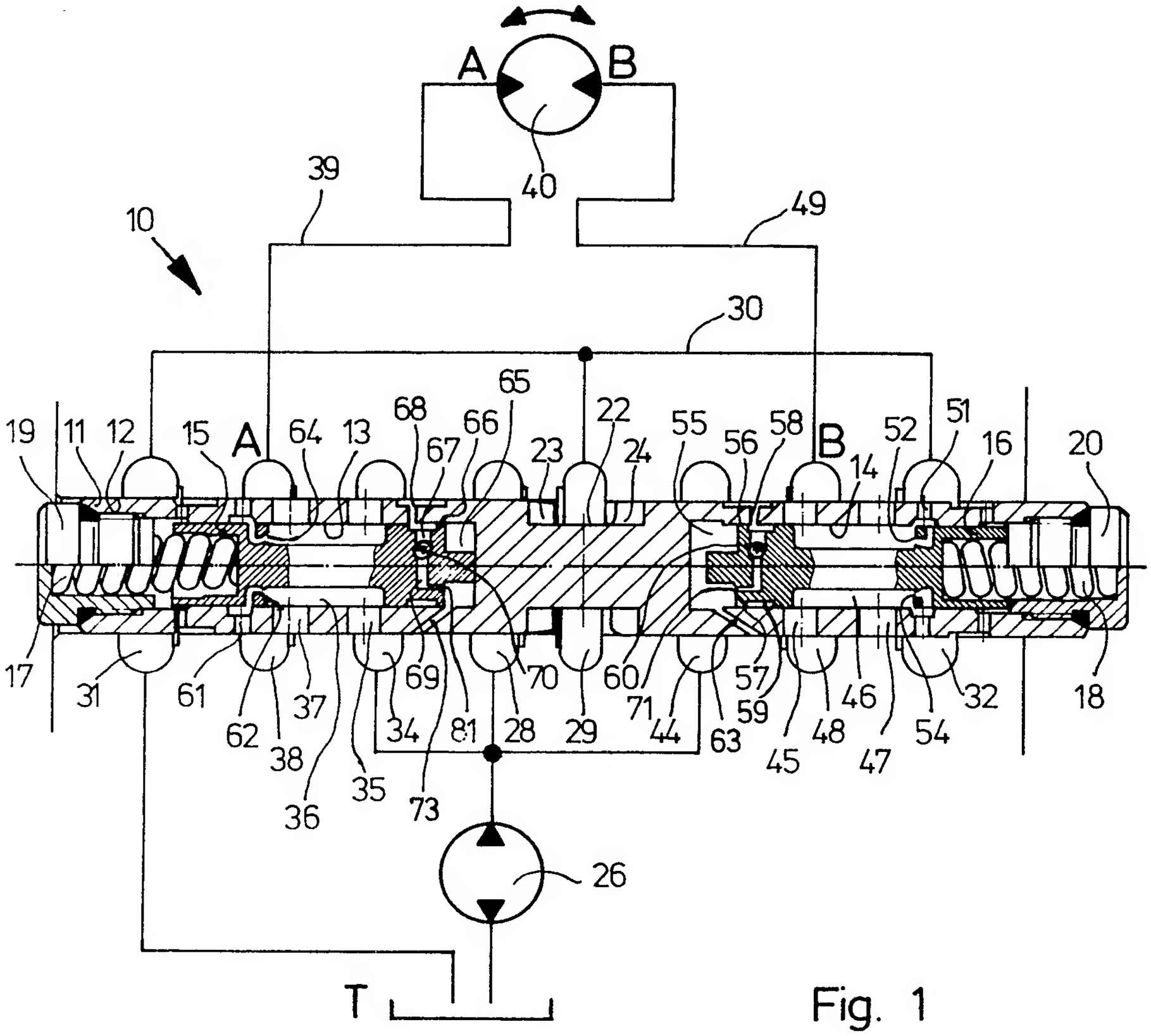
A
B
40
39
49
10
30
65
68
66
22
55
58
51
19
11
12
15
A
64
13
67
23
24
56
B
52
16
20
14
17
31
61
62
37
69
70
60
57
46
32
18
38
34
81
28
29
71
44
63
59
48
54
36
35
73
45
47
26
T

Fig. 1

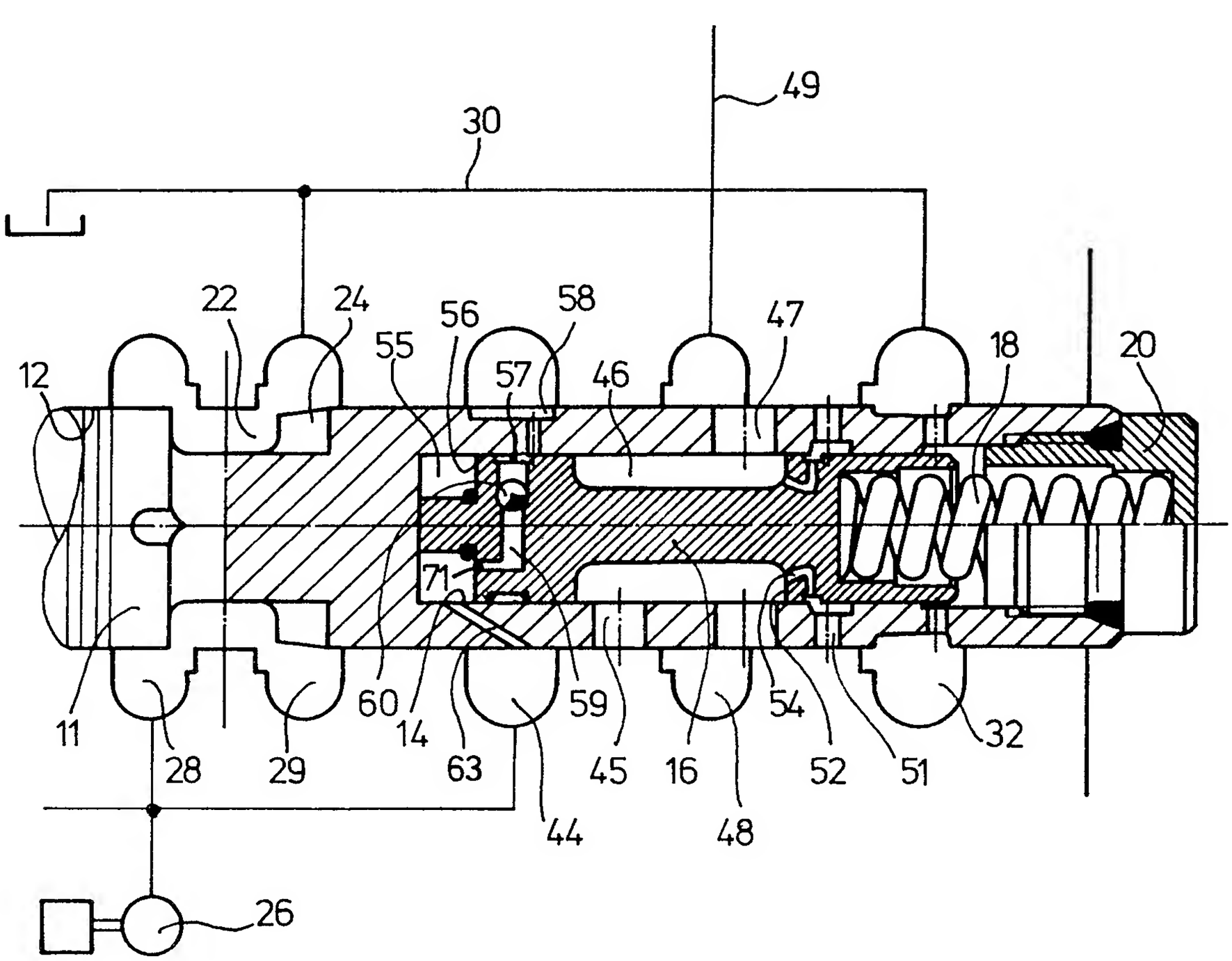
49
30
22
24
56
58
55
57
46
47
18
20
12
71
11
28
29
60
14
63
59
45
16
54
52
51
32
44
48
26

Fig. 2

SPECIFICATION

A switching valve with brake pistons

The invention concerns a switching valve with brake pistons of the kind comprising a control piston provided with boreholes in each of which a brake piston is provided, each brake piston, in the operating position of the control piston, being displaced in the direction of opening, against the force of a spring bearing against the control piston, by the supply pressure of the pump being delivered into a control chamber between the brake piston and the control piston, during which displacement a controlling cross-sectional area for the exhaust flow of the pressure medium from the fluid operated device to the reservoir is opened, and which brake piston is displaced by the spring in the direction of closure when the supply pressure is dropping, during which displacement the controlling cross-sectional area is throttled.

The function of such valves with brake pistons is to prevent a vehicle, such as an excavator, from running forward quickly when travelling downhill and in making possible a safe descent. Such valves can also be used with other fluid-operated devices, for example a hydraulic crane motor for easing down a load.

In the switching valve according to the invention there is provided a double acting switching valve with two built-in brake pistons, so that the fluid-operated device can be braked in both directions of rotation, in case it is operating as a pump driven by a load.

The invention stems from a known valve, in which one brake piston in each case is fitted in a borehole in the end of the control piston of the switching valve. The brake piston is acted upon by the pump supply pressure and controls the flowback of the operating medium from the fluid-operated device to the reservoir. As long as the supply pressure of the pump, and thus the fluid-operated device pressure, is great enough, the brake piston opens fully the exhaust flow cross-sectional area for the pressure medium from the fluid-operated device to the reservoir. When the supply pressure is dropping, the brake piston is forced in the direction of closure by a spring and thereby has the effect that the fluid-operated device is braked because of the smaller exhaust flow cross-section. The brake pistons known until now, however, exhibit an unsatisfactory switching behaviour and an unstable operating behaviour, which causes interruptions.

The problem which forms the basis for the present invention is therefore to develop a valve with brake pistons of the kind first-mentioned above in such a way that the operating behaviour is stabilised, even at fluctuating pressures, and reliable operation is achieved in the "travelling" position as well as in the braking position of the brake piston.

According to the invention, a valve of the kind first referred to above is characterised in that the control chamber of each brake piston is connected, via an annular slot between the brake piston and the control piston borehole, a passage in the brake piston, and a non-return valve barring the way to the control chamber, with an annular recess which opens into an annular channel connected with the pump.

Other preferred features of the invention are set out in the accompanying subsidiary claims.

By means of the characterising features of the invention, the switching behaviour of the brake piston is stabilised. Thus when the traction motor is speeded up the opening motion of the brake piston takes place slowly and under damping, since the pressure in the control chamber of the brake piston rises gradually. A situation is avoided in which, when the control piston is displaced into an operating position, the pressure in the control chamber rises so suddenly that the brake piston makes excessively quick and sudden movements against the force of the spring, which lead to an unstable manner of operation. Conversely, on going over to the braking position the motion of the brake piston takes place very quickly, so that the traction motor—for reasons of safety—cannot take on any excessively high rate of revolution and the braking action is achieved quickly and reliably. The stroke of the control piston over a period of time resembles a sawtooth function, in which the exhaust flow cross-sectional area is increased gradually but is reduced rapidly. By means of the vent provided in the channel in addition to the non-return valve, the movement of the brake piston into the braking position is also lightly damped, so that oscillations of the brake piston when there are fluctuations in pressure are avoided. A separate borehole opening into the control chamber ensures reliable start-up even when the pressure medium is cold.

In addition, the operating behaviour of the brake piston is enhanced by the features specified in Claim 4. While the pressure medium is being fed to the comsuming device via the first and second boreholes in the control piston, which are connected with corresponding annular channels, the second boreholes are blocked off for the exhaust flow of the pressure medium from the fluid-operated device to the reservoir, which instead takes place through third boreholes in the control piston, the cross-section of which is controlled by the brake piston. By means of this flow route the hydraulic resistance in the supply of the pressure medium is reduced. Supply and exhaust thus take place at any given time via the second or third boreholes respectively.

In each brake piston a bypass passage bridges the guiding edge to the third boreholes, which is always open, so that the exhaust flow to the reservoir cannot be interrupted completely, which would result in an excessive rise in pressure. Furthermore, this bypass passage makes possible an immediate response on the part of the fluid-operated device when the control piston is deflected from the central position, since via the bypass passage there is a connection to the reservoir, even before the brake piston is displaced into the "travelling" position.

Hence the switching valve with brake pistons according to the invention is distinguished by an improved operating performance, has a relatively great damping effect when it switches from the braking position into the "travelling" position and a relatively small damping effect when it switches over from the "travelling" position into the braking position. Furthermore, fluttering and oscillating motions of the brake pistons are avoided and the vehicle cannot pitch up through fluctuations in pressure caused by oscillation.

An embodiment of the invention is described in greater detail below, reference being made to the accompanying drawing in which:

Figure 1 is a diagrammatic representation of a switching valve for a traction motor with the control piston and the brake pistons shown in section; and

Figure 2 shows, on a larger scale, a section through the left half of the control piston in the valve of Figure 1.

The switching valve 10 shown in the drawing consists of a control piston 11, which is displaceable within a borehole 12 in a housing (not shown in detail) and which is formed at opposite ends thereof with axial boreholes 13 and 14 in which brake pistons 15 and 16 respectively are reciprocable. Each brake piston 15, 16 is acted upon by a spring 17, 18 which bears against a control piston cap 19, 20.

The control piston 11 is provided at its centre with an annular peripheral recess 22 with precision control grooves 23 and 24. In Figure 2 the control piston 11 is shown in the central neutral position, in which the pressure medium delivered by a pump 26 is conveyed via an annular channel 28 in the housing, the annular recess 22 and an annular channel 29 in the housing into a conduit 30 which is connected with annular channels 31 and 32 in the housing as well as with the reservoir T. In the central position shown in Figure 2 the hydraulic fluid thus flows away to the reservoir without pressure. If the control piston is displaced to the right or left into an operating position, the pressure medium delivered by the pump 26 is throttled, to a greater or lesser extent, at the precision control grooves 23 and 24 and thereby undergoes a rise in pressure. In Figure 1 the control piston 11 is in the operating position fully deflected to the right, in which the annular channel 28 is fully closed off and the entire output of the pump 26 flows via annular channel 34, a first borehole 35, annular recess 36 in the brake piston 15, a second borehole 37, an annular channel 38, and a conduit 39 to a traction motor 40, belonging for example to an excavator. Since the throttling of the pressure medium for control purposes takes place via the annular recess 22 and/or the precision control grooves 23, 24 the passage of the pressure medium from the annular channel 34 to the annular chnn el 38 is essentially unhindered.

On the opposite side of the control piston 11 the corresponding annular channels are indicated at 44 and 48, the first and second boreholes at 45 and 47, and the annular recess at 46. It can be seen from Figure 1 that the second boreholes 47 are blocked off by the position of the control piston 11 in the valve housing, so that the pressure medium flowing away from the traction motor 40 via a conduit 49 is conveyed via third boreholes 51 in the control piston 11 to the annular channel 32 and via the conduit 30 back to the reservoir T. The passage through the third boreholes 51 out of the annular recess 46 is regulated by a guiding edge 52 on the brake piston 16. Operating medium can always flow via a bypass passage 54 in the brake piston 16 or 15 into the ann ular chann el 32.

In normal traffic operations, i.e. when proceeding on the level, uphill or accelerating, the brake piston 16 must be moved into the position shown in Figure 1, i.e. the guiding edge 52 must open up the entire cross-section of the third boreholes 51, so that the pressure medium displaced by the traction motor 40 can flow away unhindered to the reservoir and the motor can thus develop its full output.

For this purpose a control chamber 55 is provided between the brake piston 16 and the closed end of the borehole 14; it is connected via an ann ular slot 56 between the brake piston 16 and the borehole 14, an annular recess 57 in the brake piston and a passage 58 in the control piston 11 with the annular channel 44, in which the pressure is the pressure of the traction motor or, as the case may be, of the pump feed. By means of this pressure, when the vehicle is travelling or accelerating, the brake piston 16 is displaced against the force of the spring 18 towards the right, into the opened position, in which the guiding edge 52 opens up the third boreholes 51.

In Figure 1 the corresponding third boreholes on the other side of the control piston 11 are indicated at 61, the guiding edge of the brake piston 15 is indicated at 62, and the bypass passage at 64. Appropriate provision is made for a control chamber 65, an

annular slot 66, an annular recess 67 and a passage 68. Furthermore the control chamber 55/65 is connected at any given time via a passage 59/69 and a non-return valve 60/70 with the annular recess 57/67.

The right-hand half of the control piston is shown in Figure 2 on an enlarged scale. When the control piston 11 is displaced, for starting-up or acceleration, towards the right into the operating position, as shown, so that the pressure of the pressure medium delivered by the pump 26 rises, the control chamber 55 is also immediately acted upon by this pressure via a borehole 63 in the control piston 11, so that on starting up, even with cold pressure medium, the buildup of pressure in the control chamber 55 begins at once, while the buildup of pressure via the ann ular slot 56 and the annular recess57 takes place more slowly. That is to say, by means of the rapid buildup of pressure in the control chamber 55 the brake piston 16 begins to move to the right, whereupon the borehole 63 serving for starting-up is then closed, so that the further buildup of pressure in the chamber 55 takes place via the annular slot 56 and thereby a damping of the movement of the brake piston is obtained. This damping is of material importance because a sudden rise in pressure in the control chamber 55 exerts a greater force on the brake piston 16 than the opposing force of the spring 18. By means of the damping, when pressure rises in the control chamber 55 a slow opening-up of the brake piston 16 is thereby obtained and the motion behaviour of the brake piston is stabilised.

In addition, even before the opening of the third boreholes 51 by the guiding edge 52, operating medium can flow via the bypass passage 54 from the traction motor via the conduit 49 and boreholes 51 to the annular channel connected with the reservoir, so that the traction motor responds immediately to the activation of the control piston 11. If the guiding edge 52 then opens up the cross-section of the third boreholes 51, the pressure medium displaced by the traction motor 40 can run off unhindered from the annular channel 48 via the first boreholes 45, the annular recess 46, the third boreholes 51 and the annular channel 32 to the reservoir.

If the vehicle now gets on to a downward path, so that the traction motor 40 is driven and operates as a pump, then the brake piston 16 must move to the braking position as quickly as possible, for reasons of safety. When proceeding downhill, it would be possible, without brake pistons, for the motor 40 operating as a pump to dispatch so much operating medium away to the reservoir that the filling pressure in the supply is no longer adequate and the flow of operating medium to the motor 40 breaks off. In order to prevent this, the supply pressure must be maintained. This is effected by the brake piston, which is switched into the exhaust flow as a throttle, and, controlled automatically by the supply pressure, ensures that the pressure in the supply is maintained.

Thus as soon as the motor 40 is operating as a pump, the pressure on the inflow side drops and with it the controlling pressure in the control chamber 55 also. The pressure medium in the control chamber 55 is emptied via the passage 59 and the now opening non-return valve 60 into the annular recess 57 and then via the channel 58 into the annular channel 44. By means of the reduction in pressure in the control chamber 55 the spring 18 moves the brake piston 16 in the direction of closure, in which direction the exhaust flow is monitored by the guiding edge 52, so as to maintain the supply pressure even when a downhill slope tends to cause a reduction in this pressure.

If the supply pressure drops further, the brake piston also reduces the exhaust flow cross-section further, until the supply pressure is constant again. By controlling the exhaust flow cross-section the maximum operating pressure equal to the braking pressure can be adjusted in the conduit 49 of the motor 40, so that the motor 40 is braked and a descent free of danger is made possible. Since the exhaust flow cross-section is controlled by the supply pressure which obtains in the control chamber 55, the supply pressure is held constant at every revolution of the motor. The bypass passage 54 leaves permanently open a very small exhaust flow cross-section leading to the reservoir. The movement of the brake piston 16 into the braking position can be influenced by a jet 71 for which provision is made in the passage 59. Thereby, the pressure in the control chamber 55 cann ot drop off instantaneously. The corresponding vent in the brake piston 15 is indicated at 81.

The other brake piston 15 is likewise controlled, in the operating position illustrated in Figure 1, by the supply pressure, so that the connection from the annular recess 36 to the reservoir via the annular channel 31 is interrupted.

CLAIMS

1. A valve for the control of the flow of pressure medium between a fluid operated device and a pump or reservoir, comprising a control piston provided with boreholes in each of which a brake piston is provided, each brake piston, in the operating position of the control piston, being displaced in the direction of opening, against the force of a spring bearing against the control piston, by the supply pressure of the pump being delivered into a control chamber between the brake piston and the control piston, during which displacement a controlling cross-sectional area for the exhaust flow of the pressure medium

from the fluid operated device to the reservoir is opened, and which brake piston is displaced by the spring in the direction of closure when the supply pressure is dropping, during which displacement the controlling cross-sectional area is throttled, wherein the control chamber of each brake piston is connected, via an annular slot between the brake piston and the control piston borehole, a passage in the brake piston, and a non-return valve barring the way to the control chamber, with an annular recess which opens into an annular channel connected with the pump.

2. A valve according to Claim 1, wherein a jet is provided in the passage between the control chamber and the non-return valve.

3. A valve according to Claim 1 or Claim 2, wherein a borehole is provided between the control chamber and the annular channel connected with the pump, which borehole, in the central position of the control piston, opens into the annular channel and in the operating position is closed off.

4. A valve according to any one of Claims 1 to 3, wherein the control piston includes first, second and third boreholes and the brake pistons each include a second ann ular recess which, in the operating position of the control piston, is connected via the first boreholes with the annular channel connected with the pump and via the second boreholes with an annular channel connected with the supply to the fluid-operated device, and which is connected via the first boreholes with an annular channel connected with the exhaust flow from the fluid-operated device, and via the third boreholes, controlled by a guiding edge of the brake piston, with an annular channel connected with the reservoir.

5. A valve according to Claim 4, wherein, proceeding from a central annular recess in the control piston, in order to direct the pump pressure medium away to the reservoir, there are provided, at both ends of the control piston: a passage connected to the respective first annular recess in the brake piston, and first, second and third boreholes.

6. A valve according to Claim 5, wherein there is provided in each brake piston a by-pass passage by means of which the connection between the associated first borehole and the third borehole in the control piston is kept open.

7. A valve substantially as hereinbefore described with reference to the accompanying drawings.

Printed in the United Kingdom for
Her Majesty's Stationery Office, Dd 8818935, 1985, 4235.
Published at The Patent Office, 25 Southampton Buildings,
London, WC2A 1AY, from which copies may be obtained.